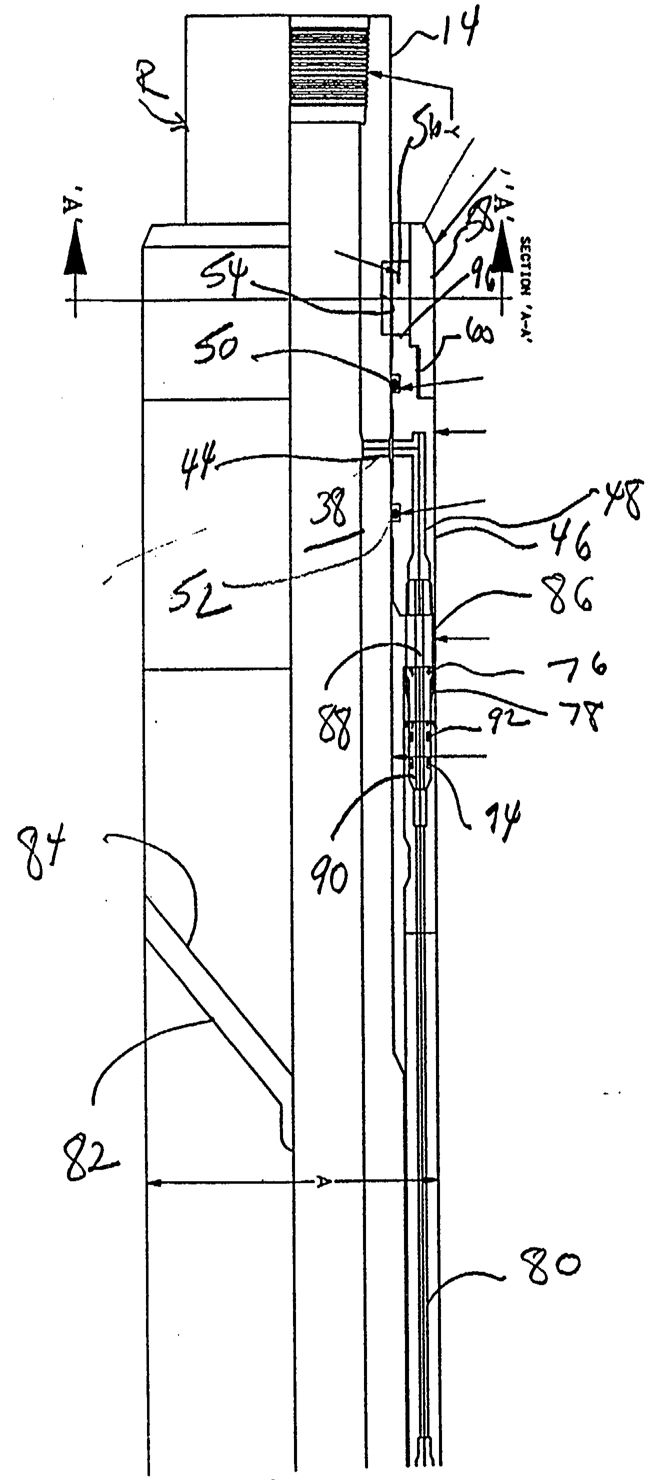

14
2
56-Y
'A'
58
96
SECTION 'A-A'
54
60
50
44
38
48
46
52
86
76
88
78
92
14
90
84
82
A
80

Fig. 1a

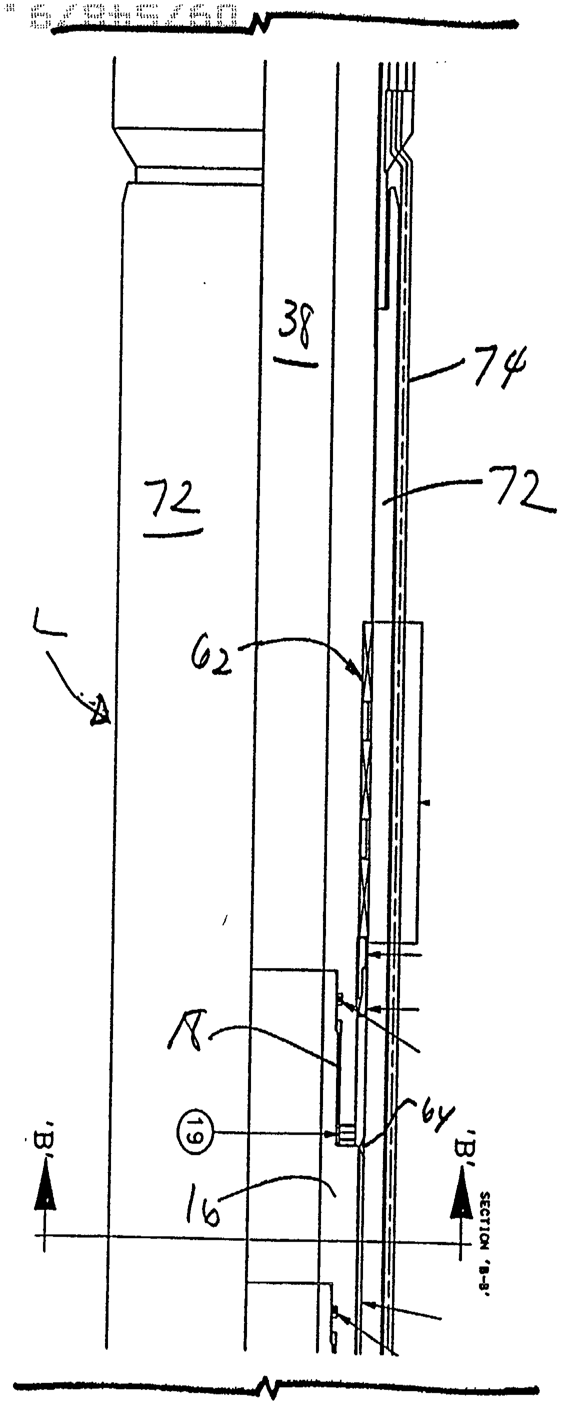

38
74
72
72
L
62
A
64
19
'B'
'B'
16
SECTION 'B-B'

Fig. 1b

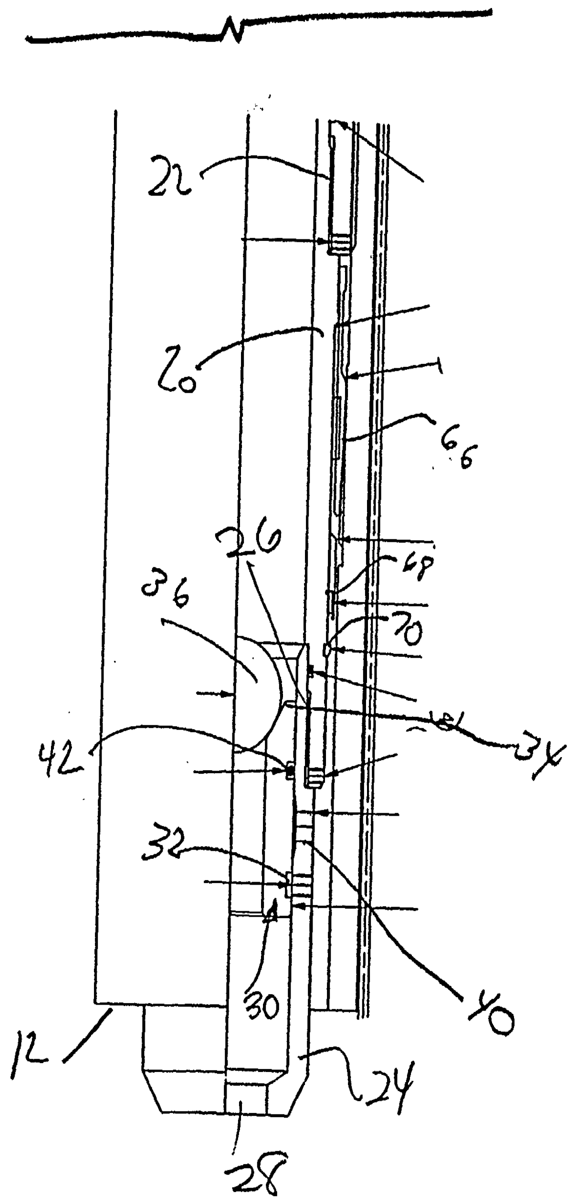

22
20
66
68
70
26
36
34
42
32
30
40
12
24
28

Fig. 1c

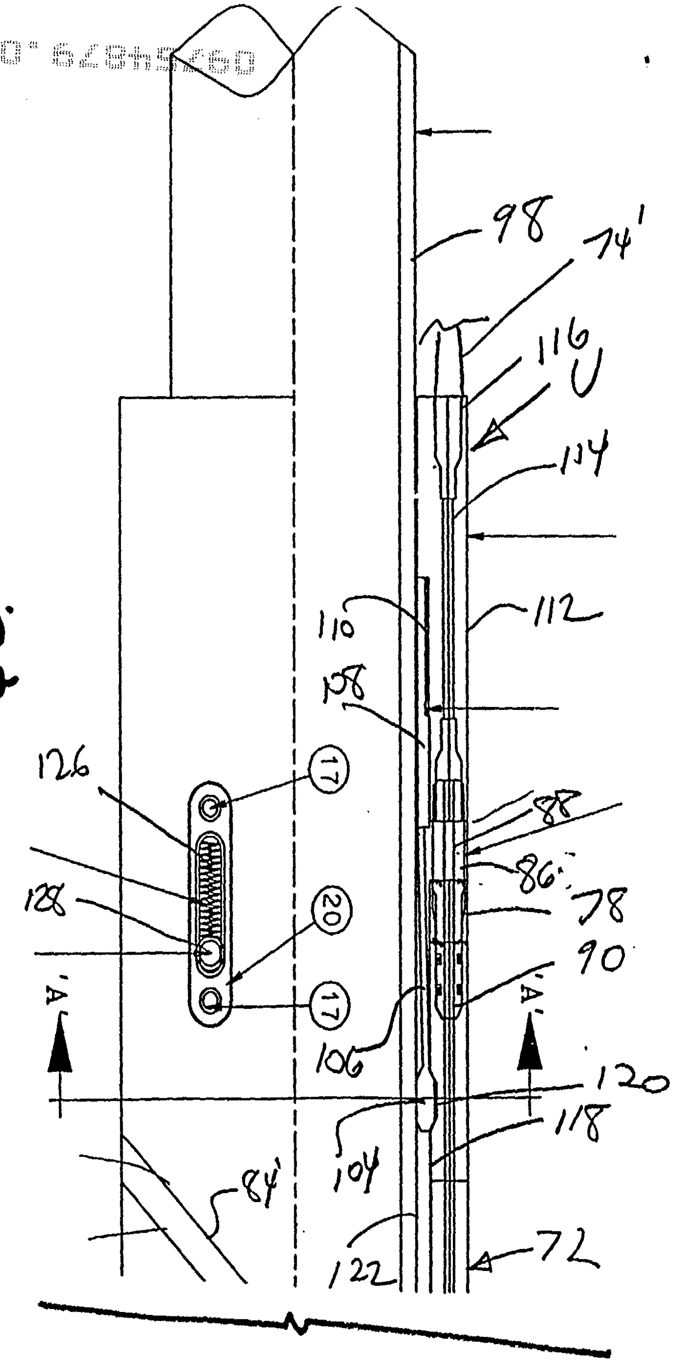

98
74'
116
114
112
110
108
88
86'
78
126
17
128
20
17
90
'A'
'A'
106
120
118
104
84'
122
72

Fig. 2a

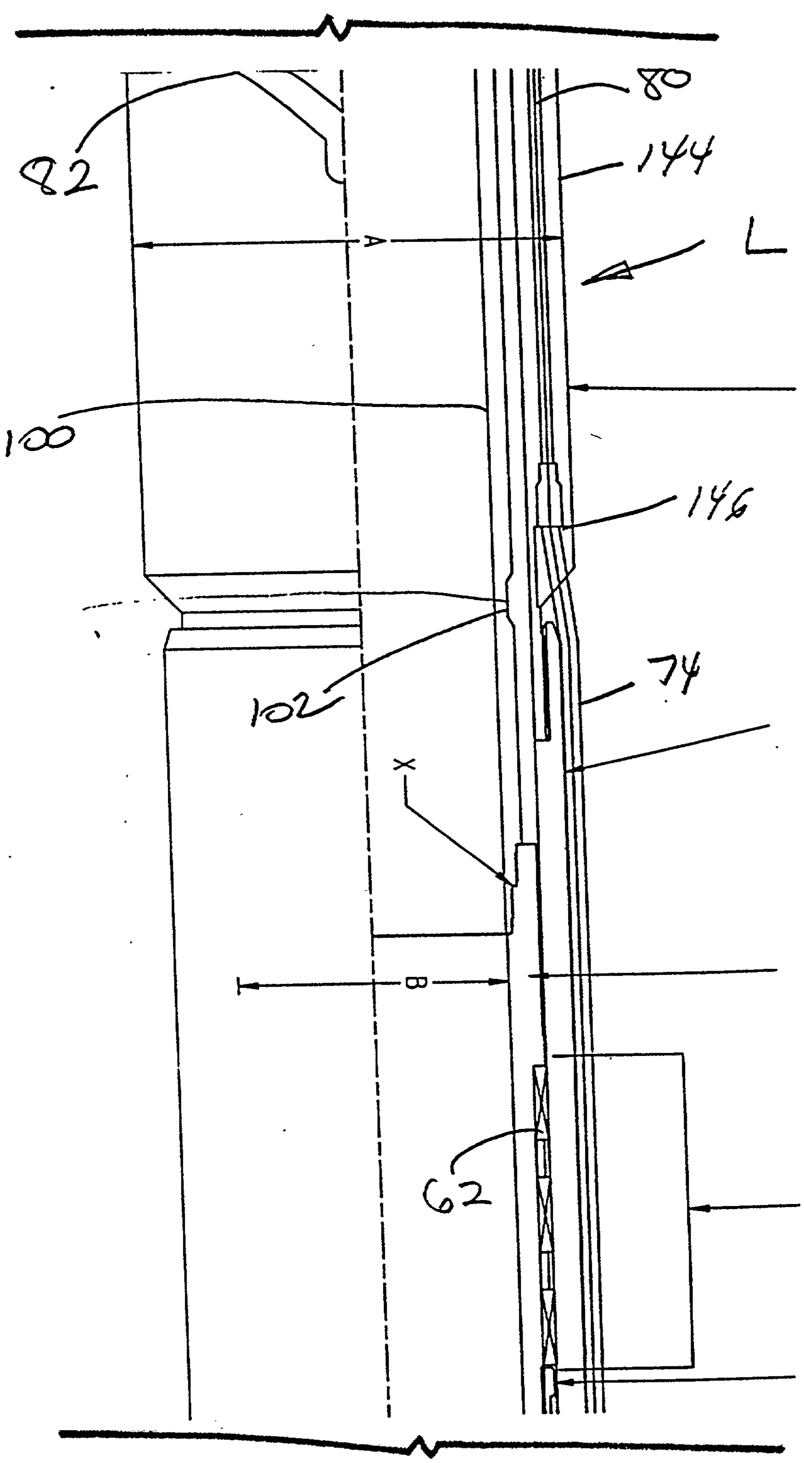


Fig. 2b

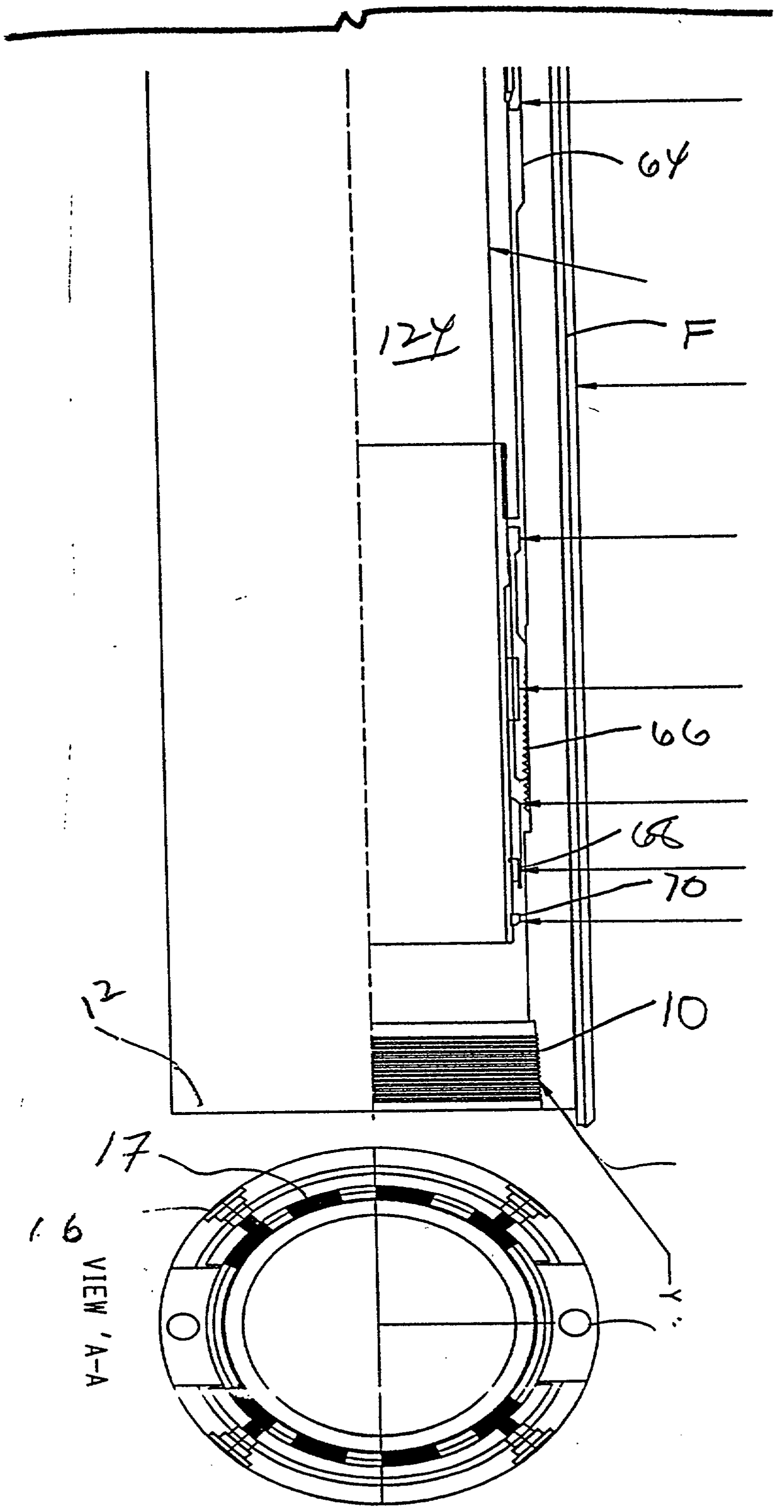


Fig. 2c

Fig. 3C

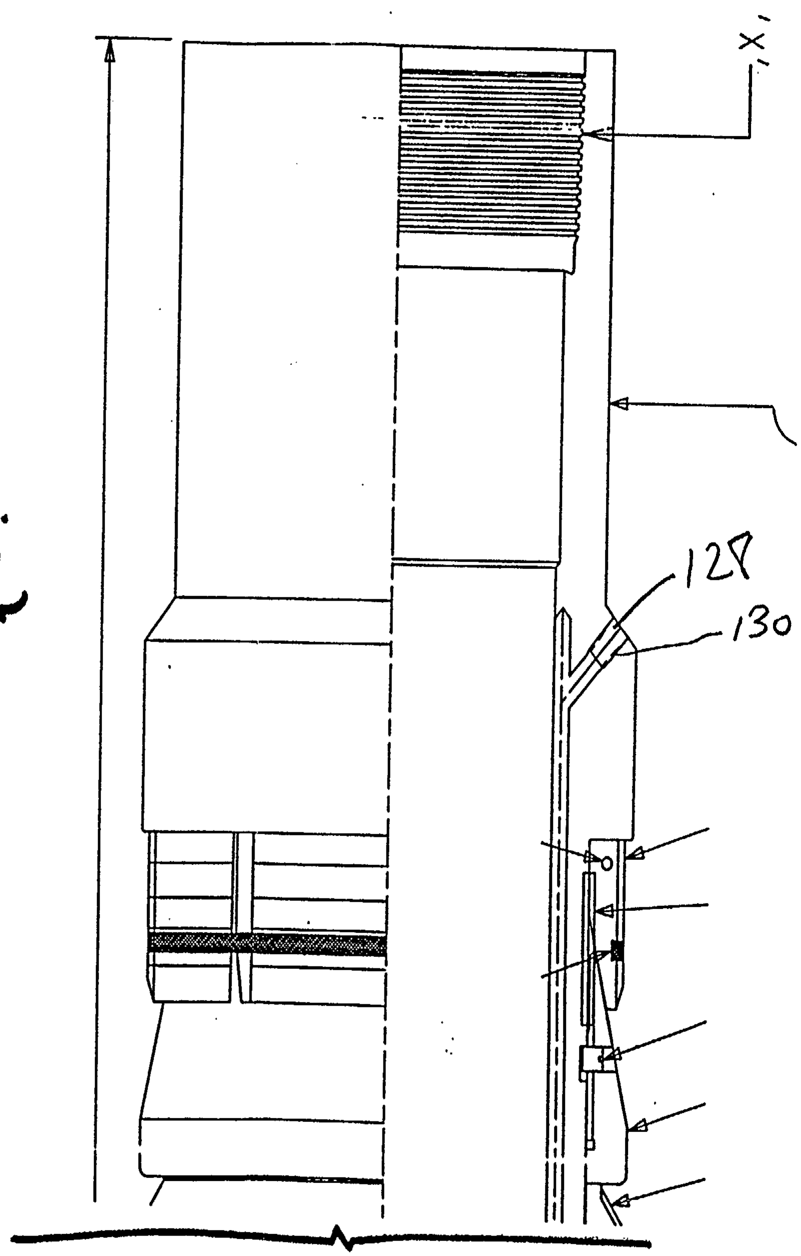


Fig. 3D

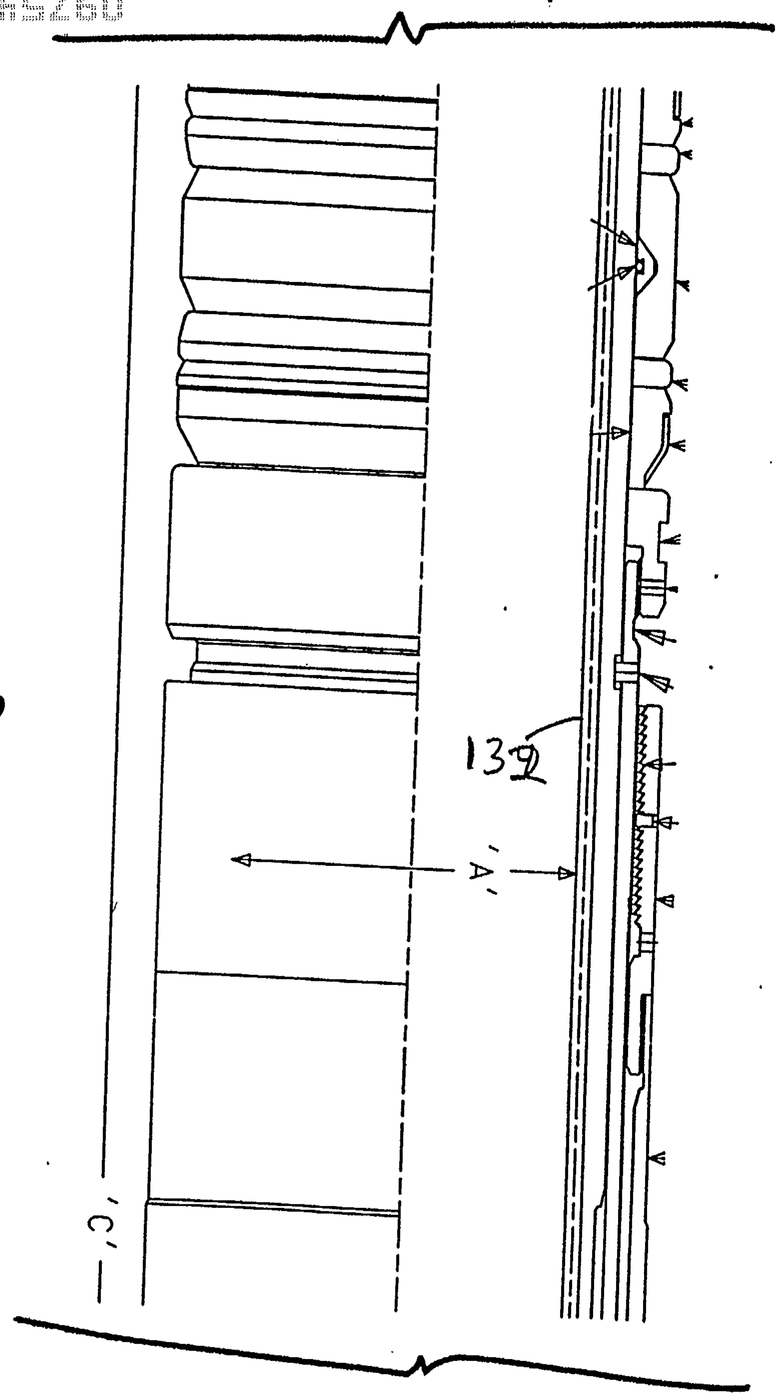


Fig. 3C

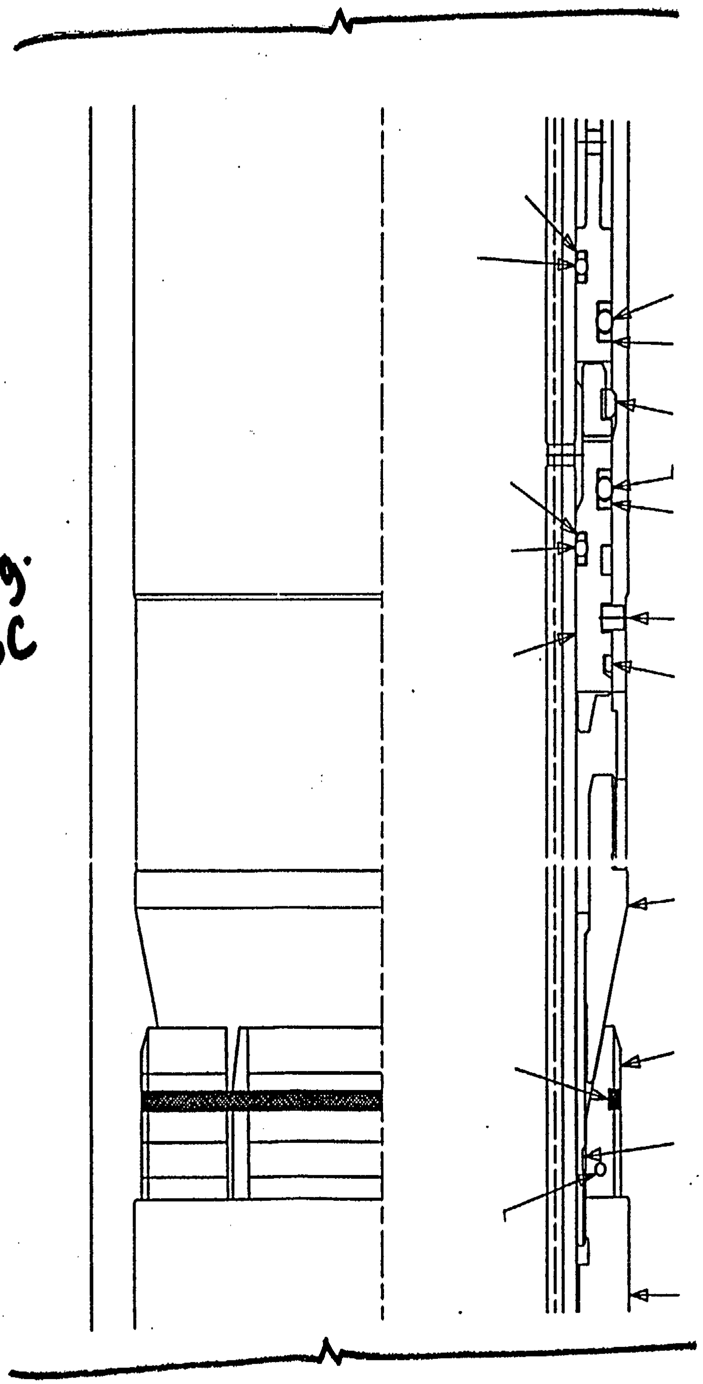
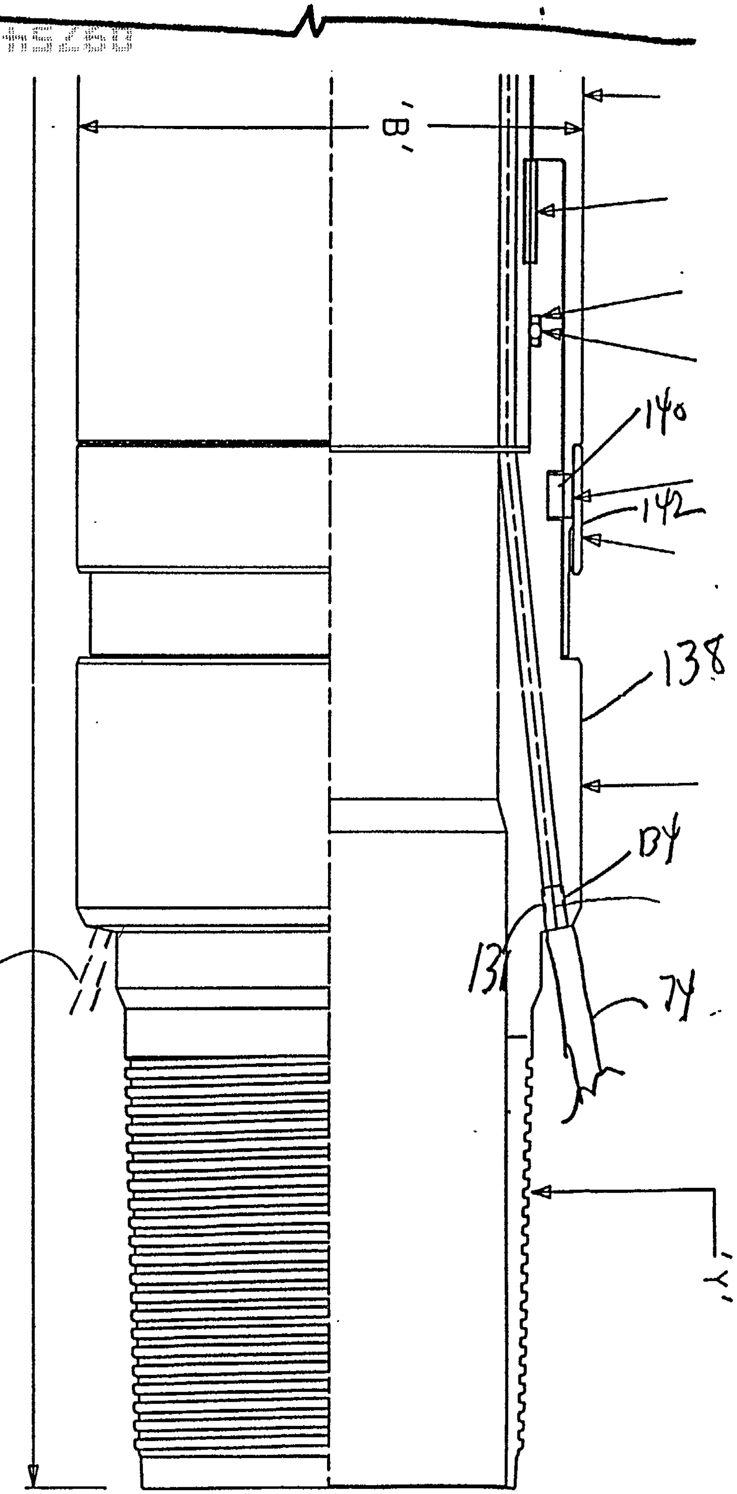


Fig. 3d



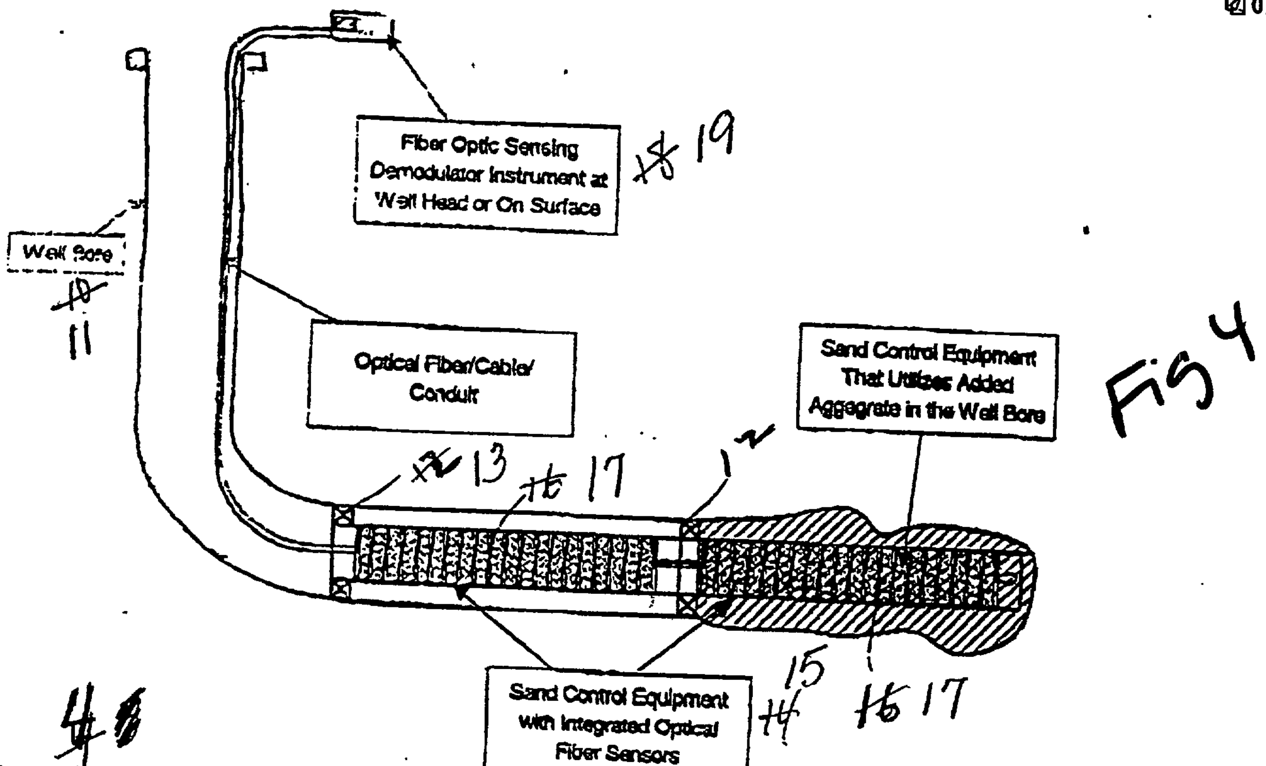


Figure 1 - Preferred Embodiment of Fiber Optic Monitoring of Sand Control Equipment.

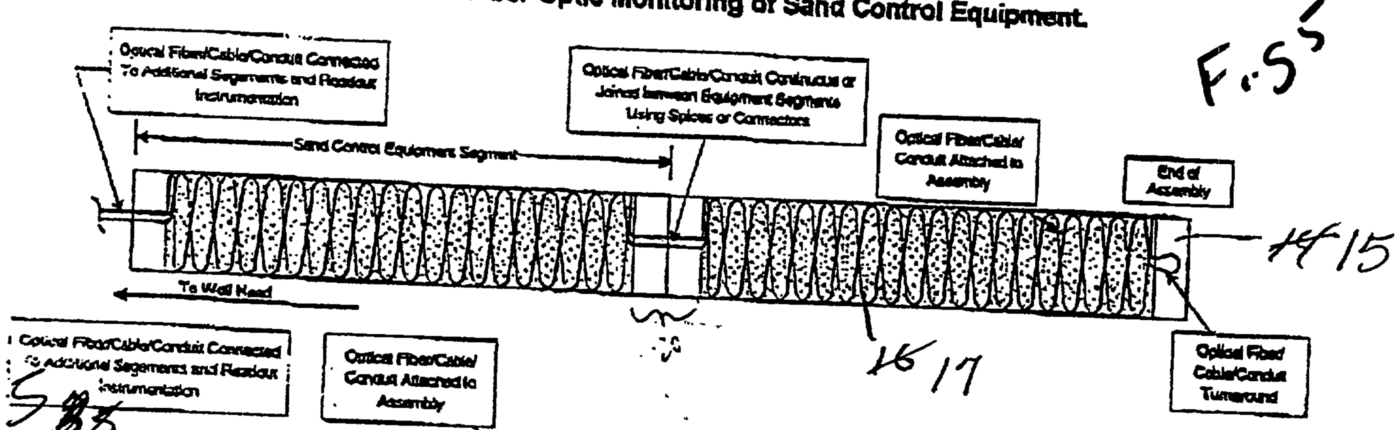


Figure 2 - Preferred Embodiment showing Optical Fiber wrapped around the circumference of the equipment on the outside surface or inside the outer diameter of the equipment.

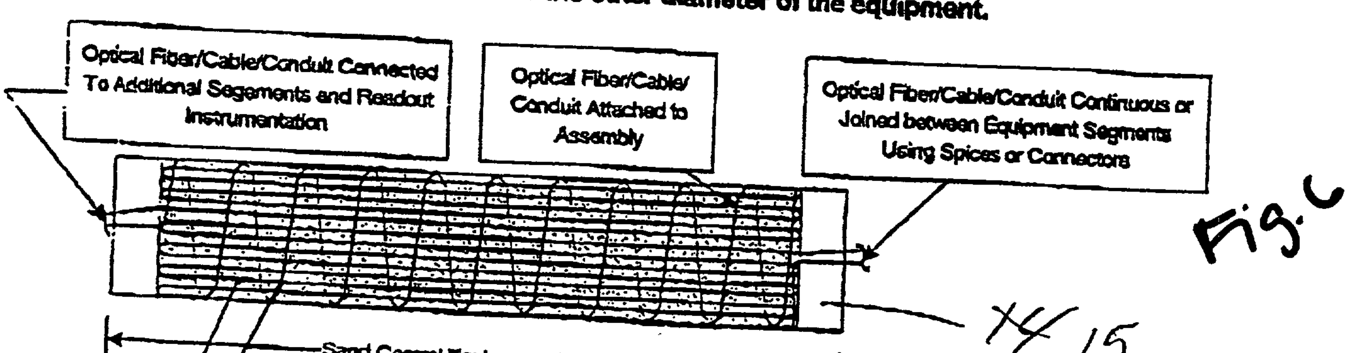


Figure 3 - Optical Fiber system with cross hatched wrapping pattern

6 17

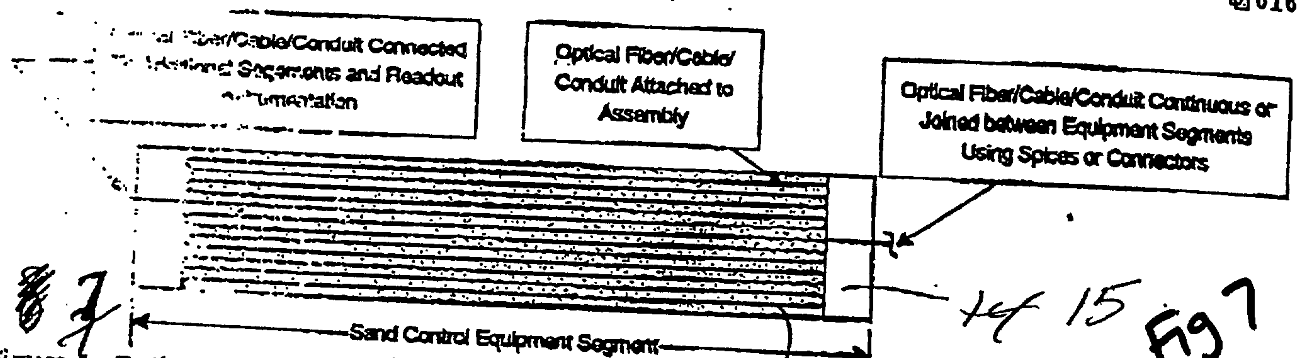


Fig 7

Figure 6 - Optical Fiber system with axial oriented wrapping pattern

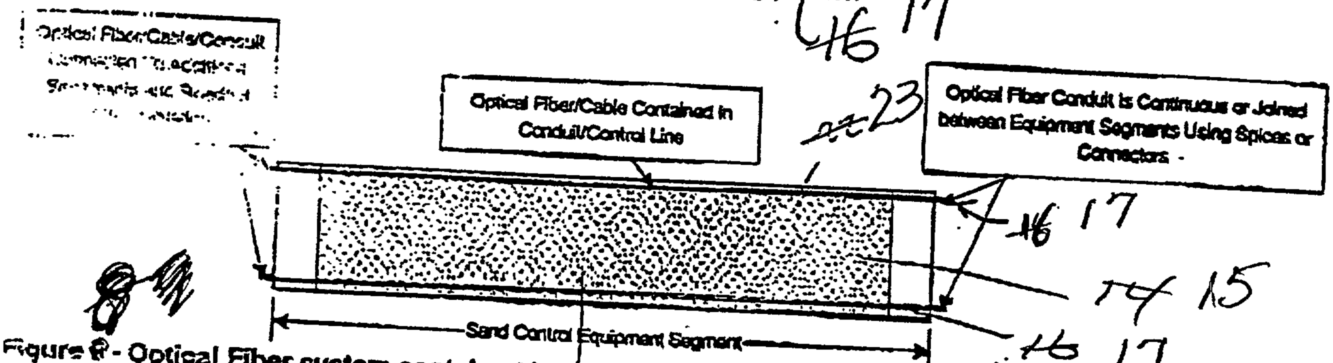


Figure 7 - Optical Fiber system contained in a conduit(s) that is located either on the outside of the equipment or inside the outer wall of the equipment

14 15

Fig 8

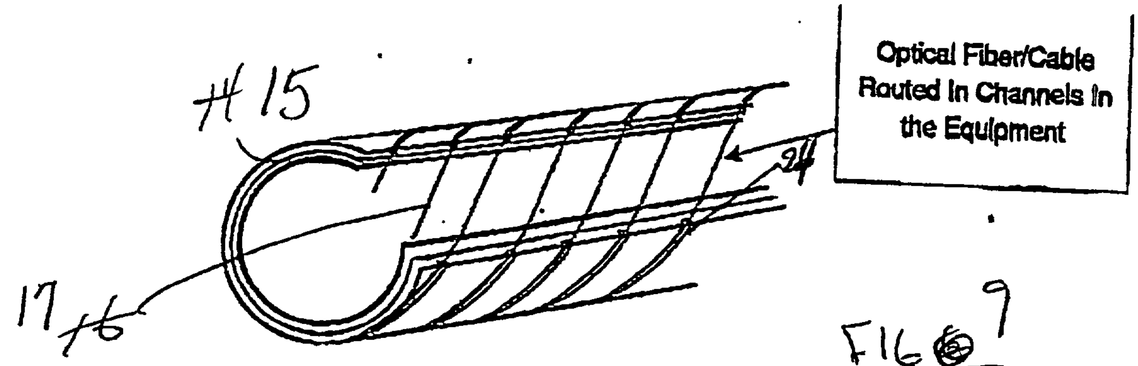


FIG 9

Equipment with Channels To Protect Optical Fiber/Cable

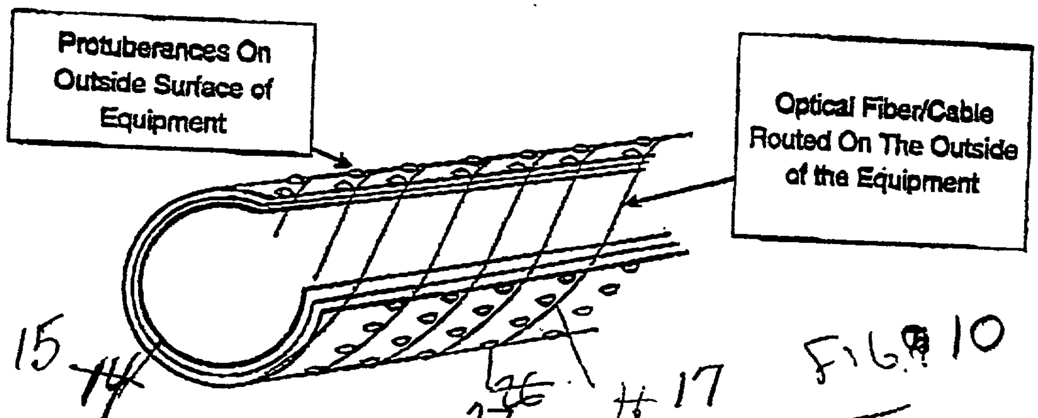


FIG 10

Equipment with Protuberances To Provide a Standoff To Protect Optical Fiber/Cable

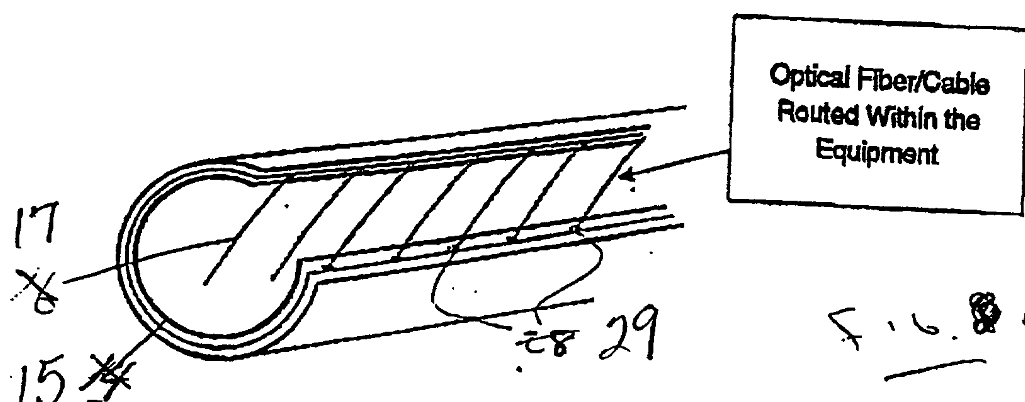
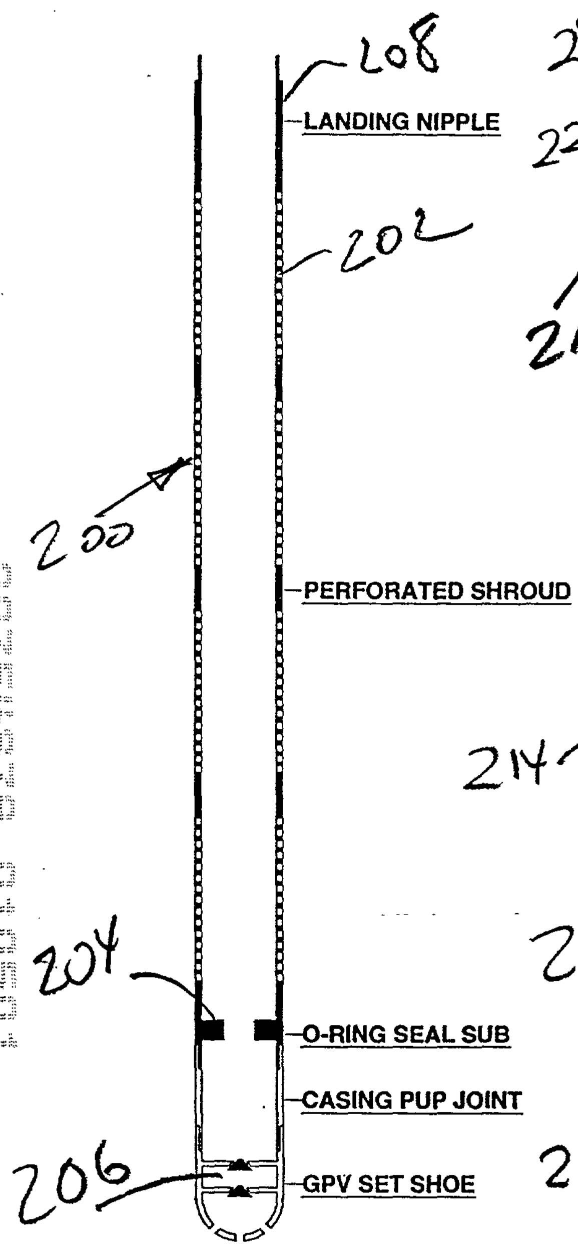


FIG. 11

Equipment with Integrate Optical Fiber/Cables

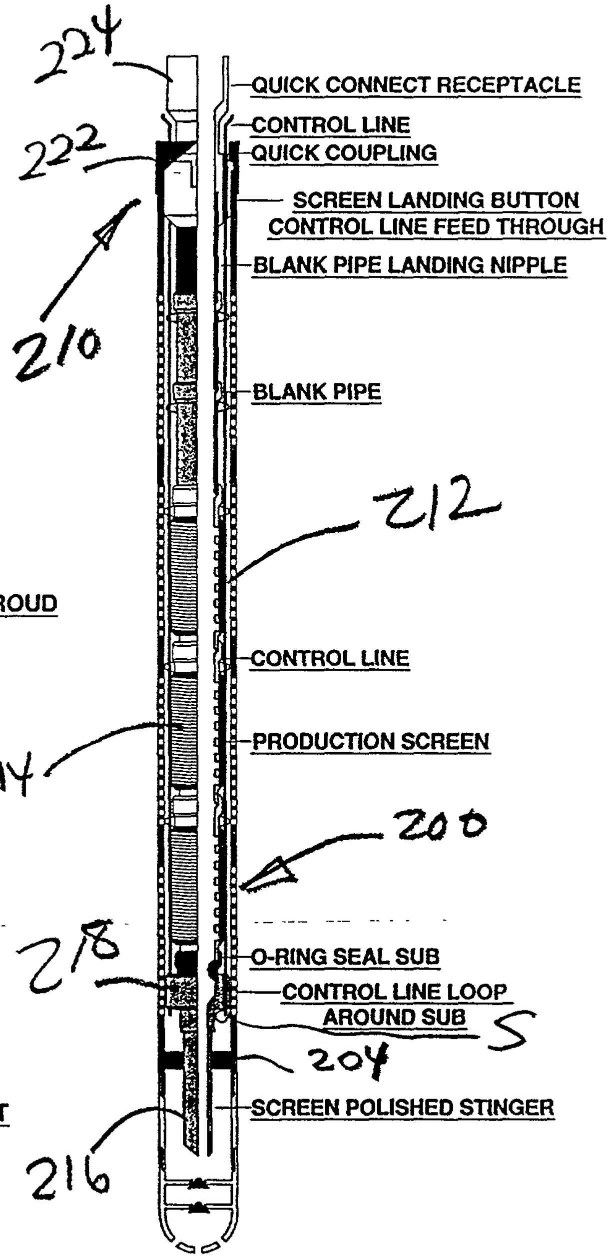
SCREEN / LINER SHROUD ASSEMBLY

Open Hole : 8.500 inches
Maximum OD of Shroud : +/- 7.625"
Minimum ID of Shroud: 7.000"
Screen OD : 5-1/2" EXCLUDER2000 w/ 6.375" OD
Design w/ Near or Flush OD connections to be provided by SC Engineering (Rick Peterson – Ref GANNT Chart)



SHROUD ASSEMBLY

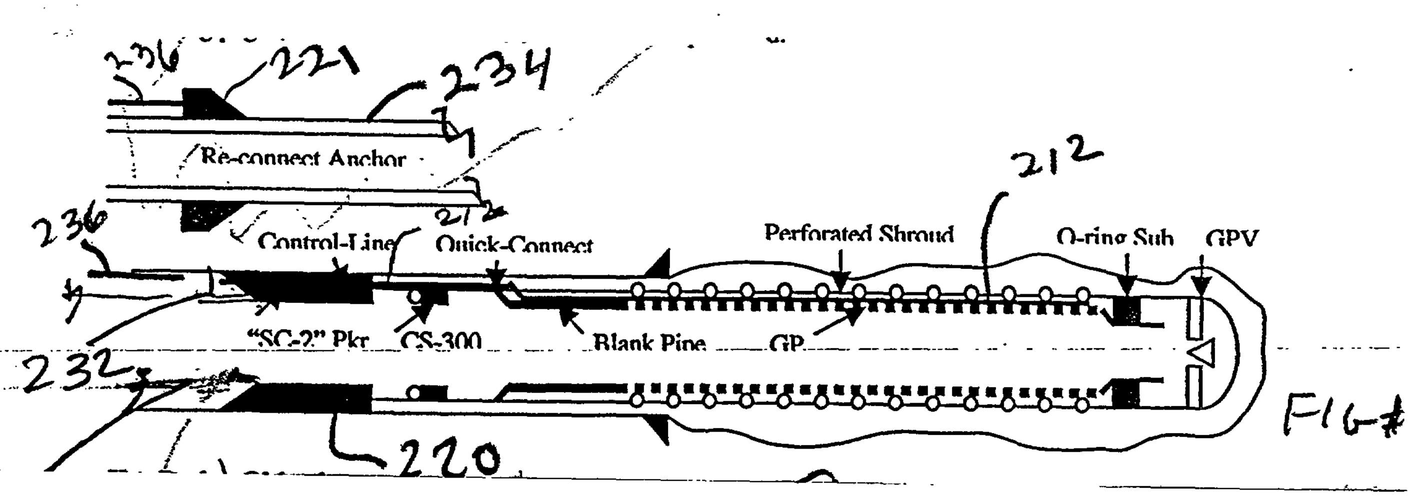
FIG #12



SCREEN ASSEMBLY

FIG #13

 12/16/99



236
221
234
Re-connect Anchor
212
236
Control-Line
Quick-Connect
Perforated Shroud
O-ring Sub
GPV
"SC-2" Pkr
CS-300
Blank Pipe
GP
232
220
212
FIG #

Fig 14

SC System with Fiber Optics

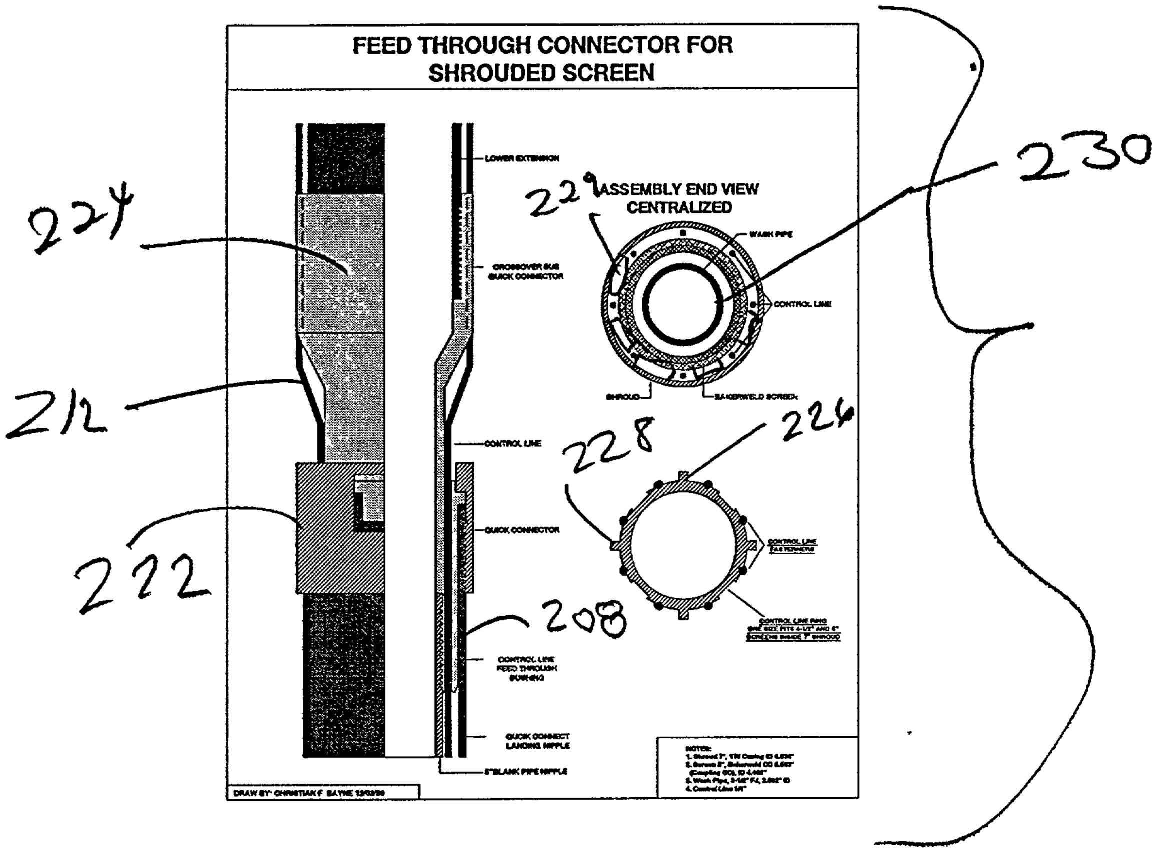
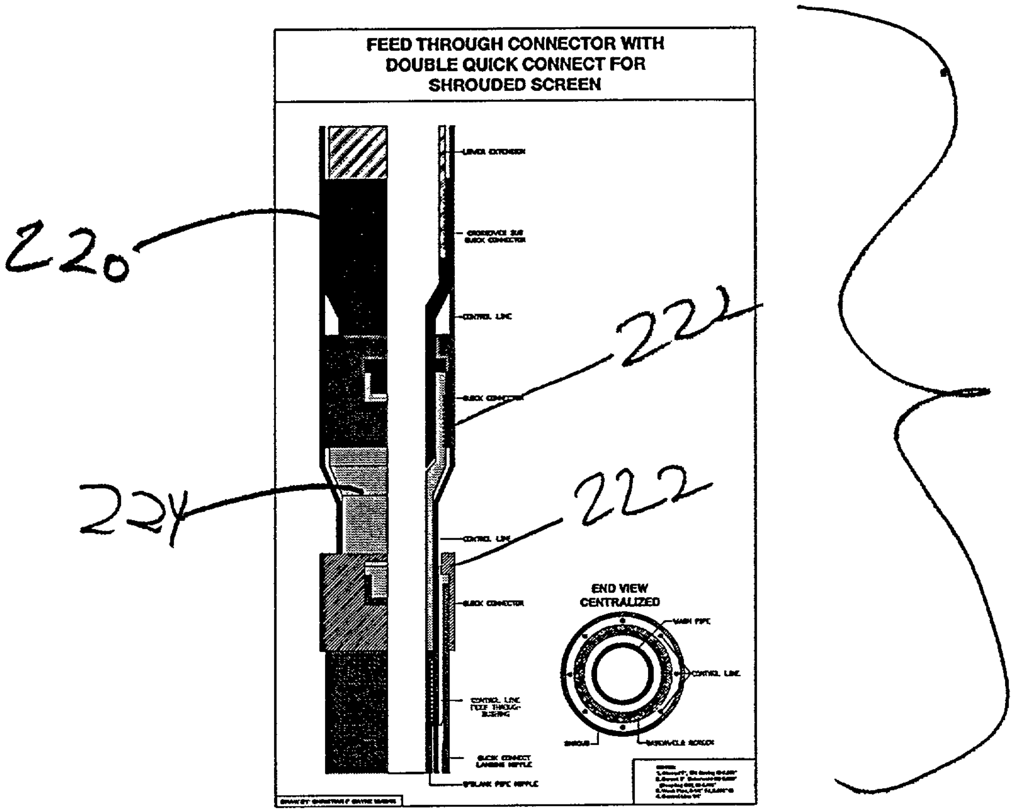
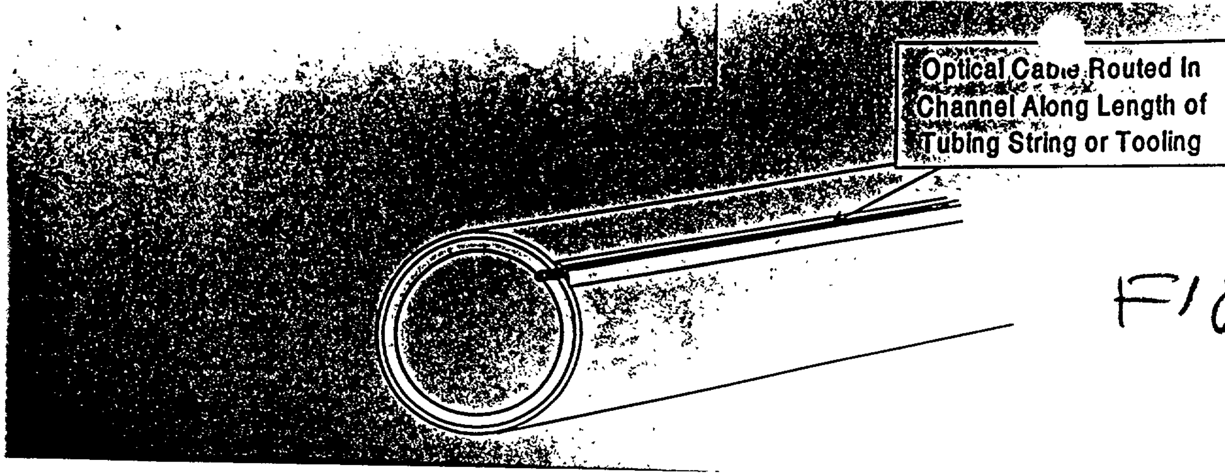


FIG #4a

SC System with Fiber Optics



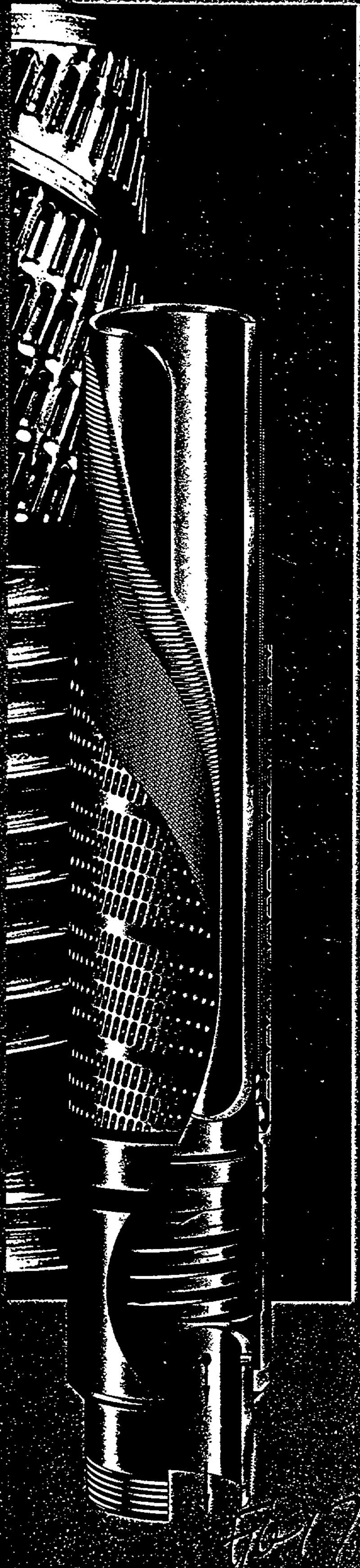
FIG#15


Optical Cable Routed In
Channel Along Length of
Tubing String or Tooling

FIG#16

EQUALIZER Production Management System

PEI
Meritorious
Award



The EQUALIZER™ is an innovative reservoir drainage system that uses an extended-longevity wellscreen and specially designed inflow control device to optimize production and delay water or gas coning in long, low-drawdown, high-rate horizontal wells. The system balances, or equalizes, longitudinal inflow along the entire length of the wellbore to ensure a uniform production profile.

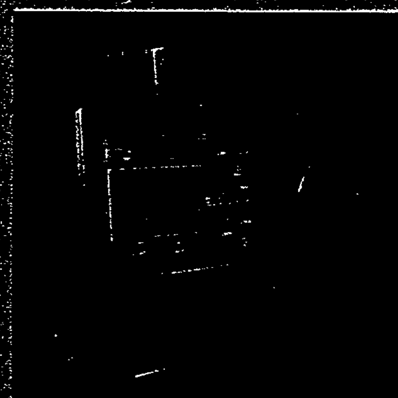
EQUALIZER design innovations

- First completion system to successfully create a uniform production profile along the entire length of a horizontal wellbore.
- First completion system to use a helical channel as a restrictive element to balance inflow from a producing formation.
- Mathematical modeling allows system to be configured with precise combination of cross-sectional area and number and length of channels to provide optimal pressure drop versus flow rate characteristics to balance well inflow, based on a particular set of formation data.
- EXCLUDER™ well screen's unique, single-layer vector membrane with uniform pore throat openings and inflow comparable to that of a formation face ensures well productivity by resisting plugging and erosion.

Inflow control device

The inflow control device (ICD) uses a helical channel as a restrictive element to impose a pressure distribution along the entire length of the wellbore. In this way, it can control the local production rate at any point along the wellbore as a function of both the average drawdown pressure and the average productivity of the well. Final screen sizing for a particular installation is based on pressure drop versus flow rate characteristics required for optimally balanced well inflow from the formation. A numerical simulator has been developed to accurately design the ICD within acceptable percentage performance. In some applications, the model is within 5% accuracy.

This accuracy rate has been verified through a series of flow tests. Engineers monitored flow



rates through varying channels with different sizes, pitches and number of spirals. After documenting the results, they developed the software used in the numerical simulator. Operators input data regarding well parameters and reservoir, as well as the pressure and rate at which they want the fluid to travel. The computer then displays the channel width, thread width, height and length required to maintain the desired pressure and fluid velocity.